

KSC Tropospheric Doppler Radar Wind Profiler Operational Acceptance Test Status

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Outline

- Background
- Data and Methodology
- Results
- Summary

Background

- Tropospheric Doppler Radar Wind Profiler (TDRWP) certification analyses consist of examining TDRWP output and comparisons to balloon measurements.
 - Analyses assume that the balloon is valid while accounting for temporal sampling differences between the balloon and TDRWP.
 - Include examination of TDRWP data quality and effective vertical resolution (EVR).
 - Full certification [specific to NASA Space Launch System (SLS)]
 - Completion would certify use of TDRWP for GO decision to launch.
 - Projected timeline of roughly one year, which is prohibitive to use the TDRWP as-is, so...
 - Operational Acceptance Test [OAT, performed for the Eastern Range (ER) / Kennedy Space Center (KSC)]
 - Completion would show that the new system is as good as the 50-MHz DRWP*, and could be used as a situational awareness tool.
 - An OAT (without a Quick-Look) was successfully performed on the TDRWP, but changes of transmission frequency, pulse shape, pulse width, and processing software necessitated a redo of the TDRWP certification process.
 - Quick-Look (performed for the ER / KSC)
 - Completion would determine that the TDRWP produces data that is of sufficient quality to assess for the OAT.
 - Timeline of three to four weeks: Completed in July, 2016.
- These charts summarize the analysis method and provide an OAT status.
- *Individual vehicle programs must decide if and how to use the TDRWP.*

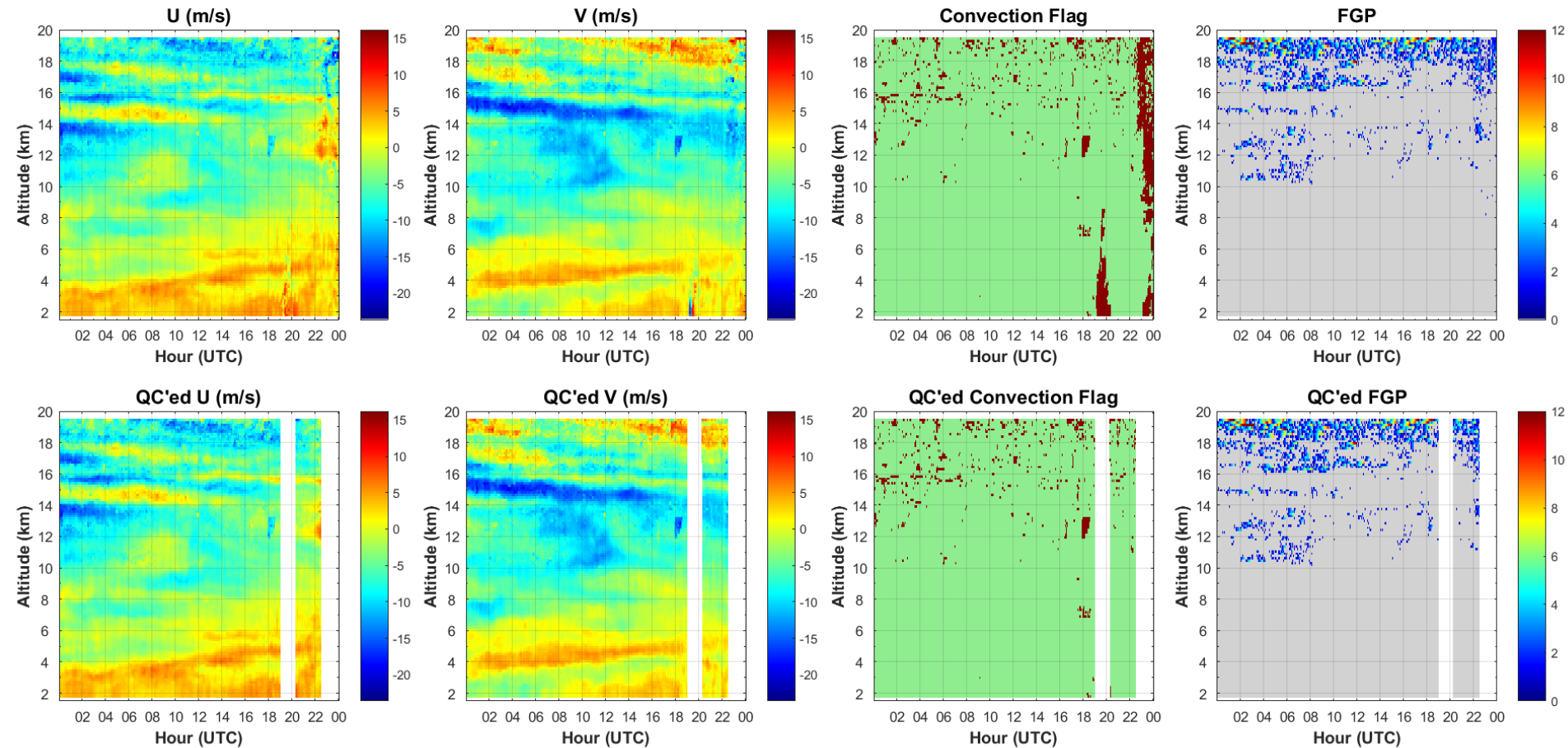
* The term “50-MHz DRWP” refers to the system that the TDRWP is replacing (i.e., the system that was decommissioned in March 2014).

Data and Methodology

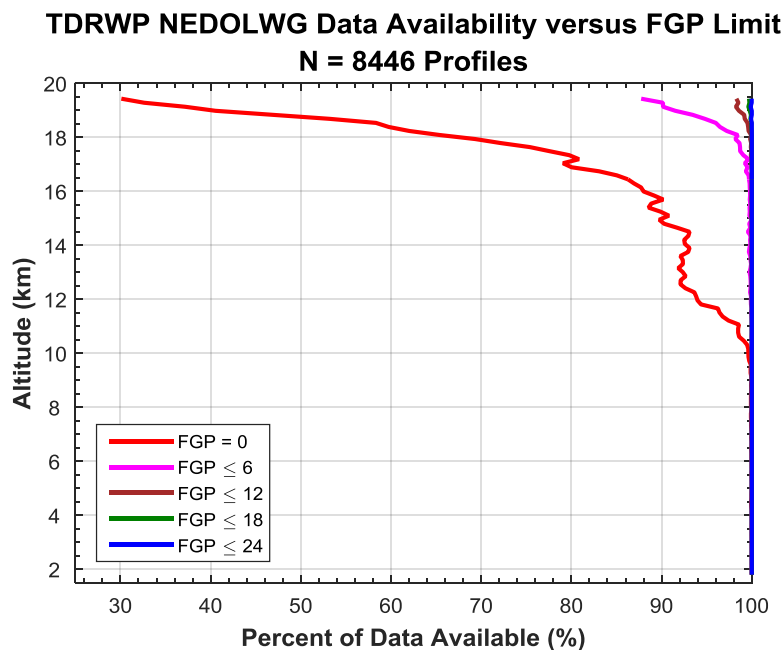
- Analysis period
 - Quick-look: June 22, 2016 thru July 1, 2016; with 30 concurrent TDRWP and balloon profiles.
 - NEDOLWG: June 22, 2016 thru July 28, 2016; with 85 concurrent TDRWP and balloon profiles.
- TDRWP Data
 - Five-minute profiles for each day from 1,795-19,430 m, every 150 m.
 - Removed entire profiles during periods of deep convection that affected wind field (“QC”).
 - Each day contains at least 100 profile pairs.
- Balloon Data
 - Automated Meteorological Profiling System (AMPS) Low Resolution (LR) and High Resolution (HR) Flight Element (FE).
 - One-second data provided by the Cape Weather Station.
 - Performed altitude limit and temporal separation QC.
- Analysis methodology
 - Visually examine TDRWP time-height (T-Z) sections.
 - Examine data availability and investigate QC flags.
 - Compute root-mean-square (RMS) wind deltas from TDRWP and balloon profiles matched in the temporal and vertical domain.
 - TDRWP spectral analysis.

Results: TDRWP T-Z Sections

06/28/2016 TDRWP Time-Height Plots

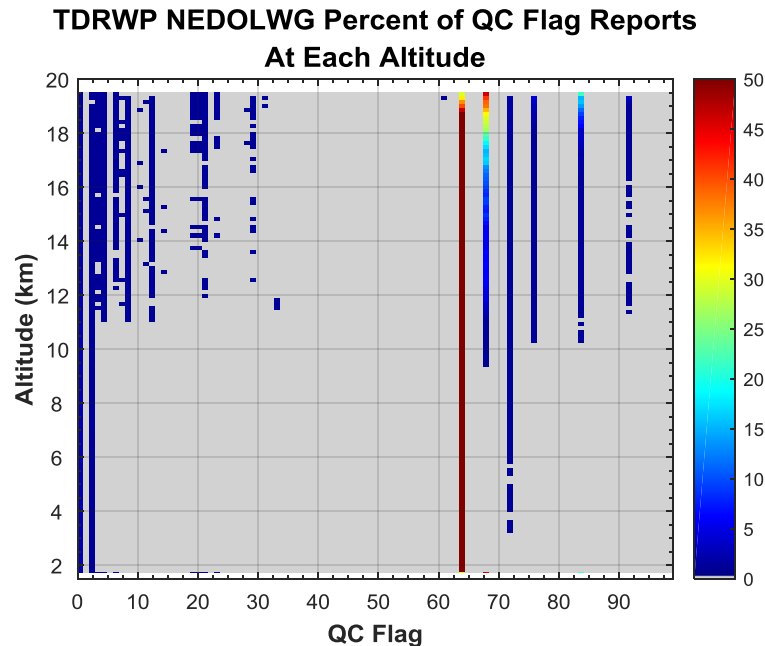


Results: Data Availability



- Plot consists of the percent of TDRWP data at a specified altitude that contain at most X number of First Guess Propagations (FGPs).
- 100% availability indicates that none of the data points at a given altitude were derived from propagating the first guess velocity (e.g., the signal was discernable above the noise floor).
- During this period, the TDRWP provided, on average, nine profiles per hour that reach ~17 km without being affected by a characteristic that propagates the first guess velocity.

Results: QC Flag Investigation

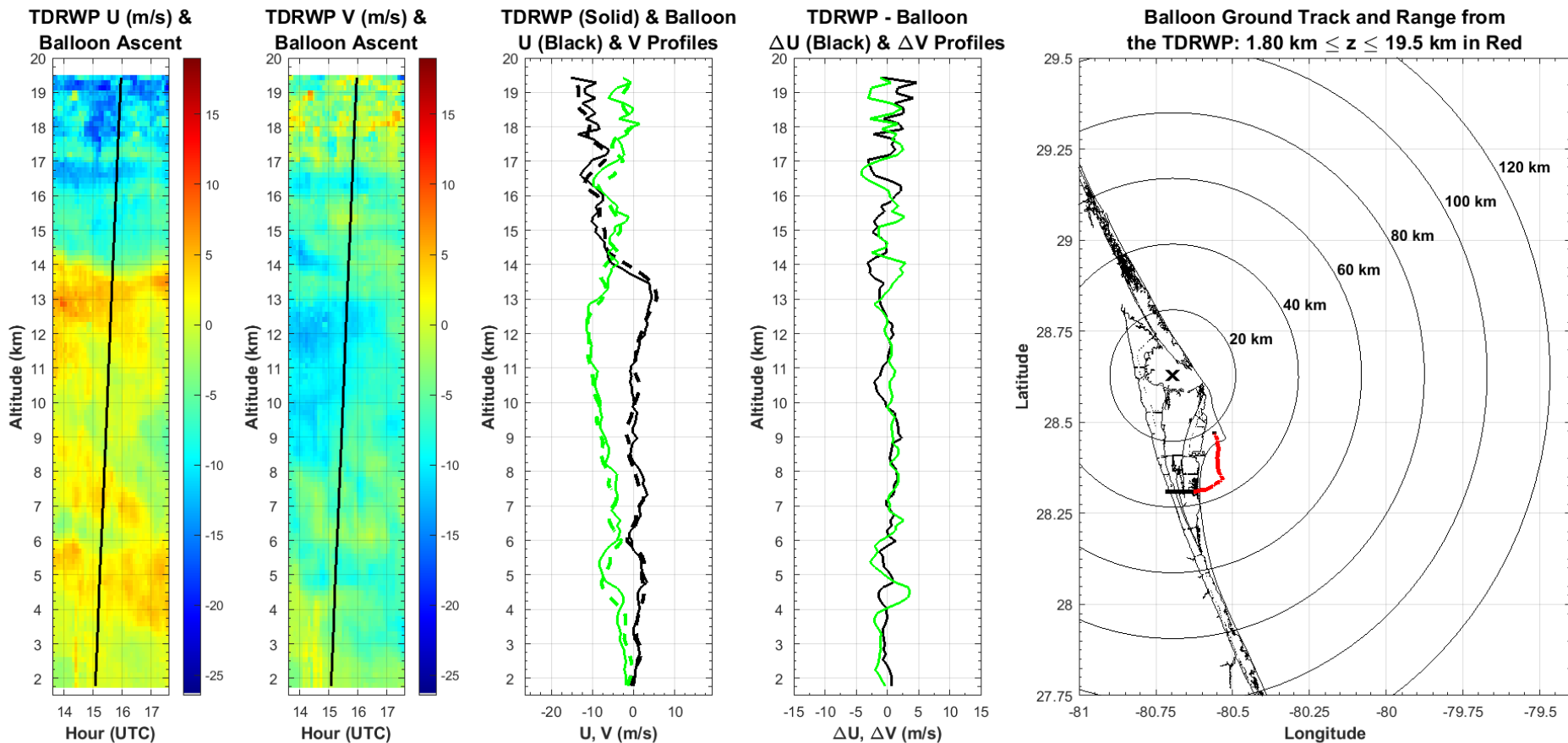


- Analysis takes advantage of QC flag reports unique to the TDRWP.
- SNR check failure is responsible for many FGP instances.
- Some QC flags (including 0, 1, 3, and 64) do not indicate suspect or erroneous data.

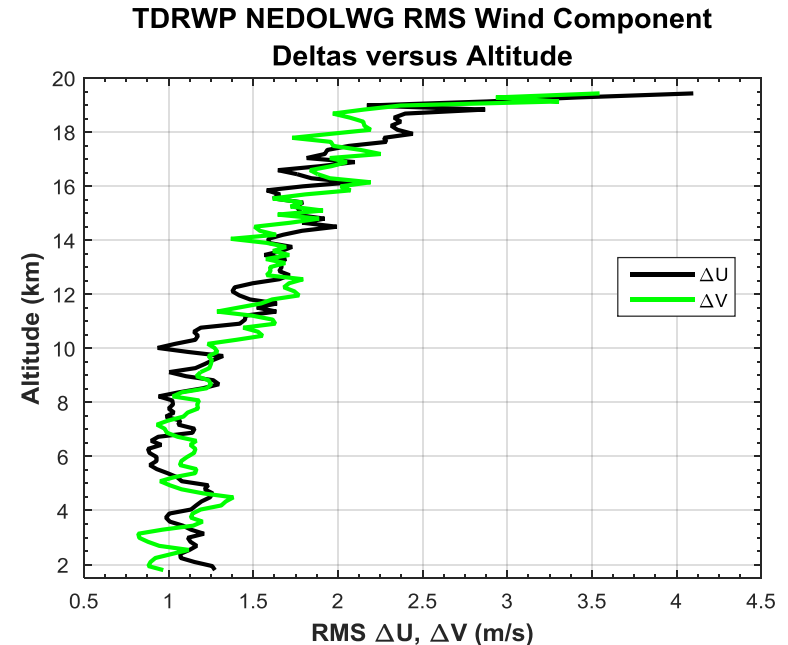
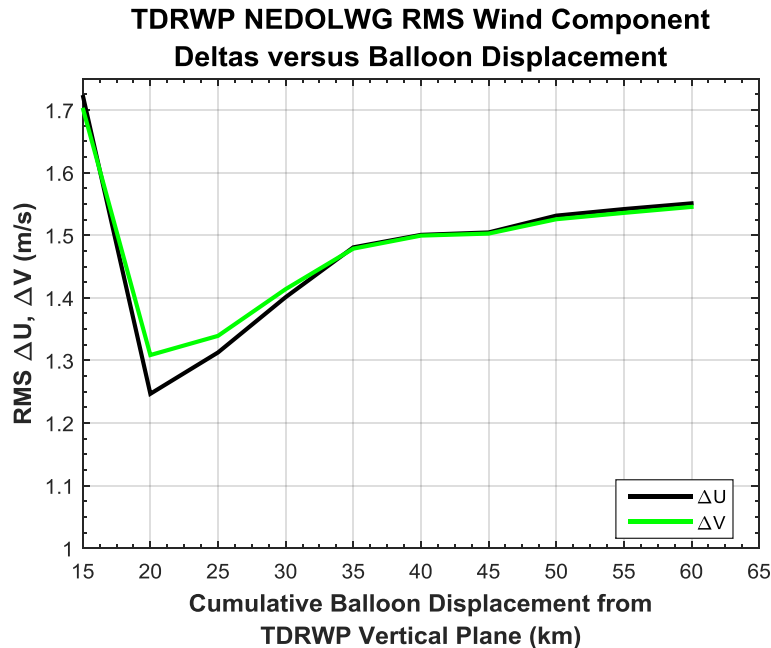
QC Flag	Description
0	Auto QC. Communication to MMQC normal.
1	Manual QC Active either at the MMQC or MSC
3	Manual QC Active, Automated Release
4	Auto QC, SNR
5	Manual QC Active, SNR
7	Manual QC Active, Auto Release, SNR
8	Auto QC, Shear
9	Manual QC Active, Shear
11	Manual QC Active, Auto Release, Shear
12	Auto QC, SNR, Shear
13	Manual QC Active, SNR, Shear
15	Manual QC Active, Auto Release, SNR, Shear
20	Auto QC, SNR, Shear
21	Manual QC Active, SNR, Shear
23	Manual QC Active, Auto Release, SNR, FGP
28	Auto QC, FGP, Shear, SNR
29	Manual QC Active, FGP, Shear, SNR
31	Manual QC Active, Auto Release, FGP, Shear, SNR
33	Manual QC Active, Bad Data
61	Manual QC Active, Bad Data, FGP, Shear, SNR
64	Auto QC.
68	Auto QC, SNR
72	Auto QC, Shear
76	Auto QC, SNR, Shear
84	Auto QC, SNR, FGP
92	Auto QC, FGP, Shear, SNR

Results: TDRWP / Balloon Comparisons

TDRWP and Balloon Comparison, Case 19: Balloon Release at 06/26/2016 15:00 UTC



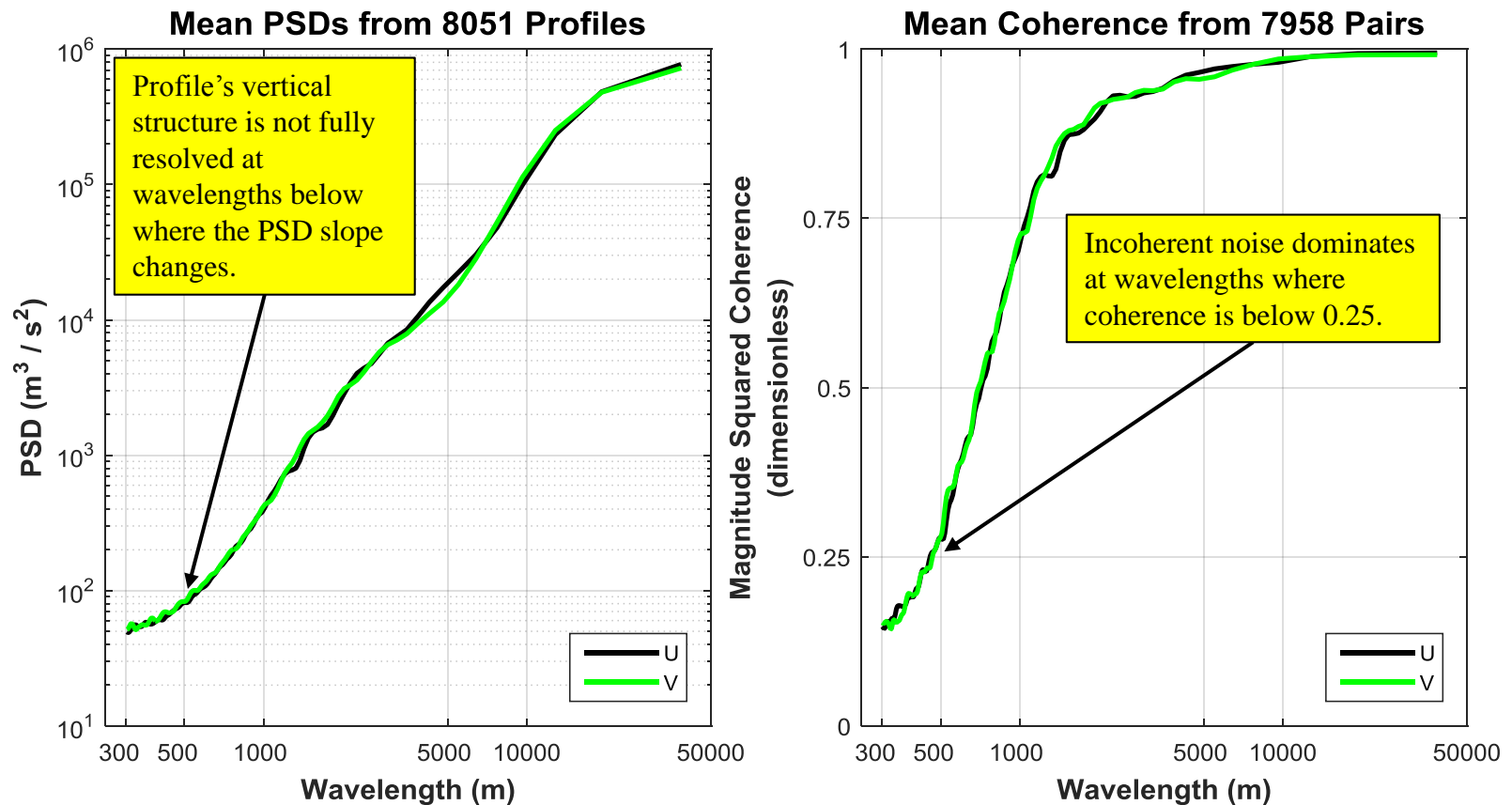
Results: Wind Component Deltas



- RMS deltas are consistent with expected differences between measurement systems.
- As anticipated, lower RMS deltas than prior OAT exist.
 - NEDOLWG (and Quick-Look) RMS deltas were ~1.5 m/s using data collected during summer.
 - OAT RMS deltas were ~2.1 m/s using data collected during winter.
 - Utilizing coordinates provided in data (versus assuming a rise rate) more accurately represents balloon location.
- Attribute at 15 km displacement is likely due to differences at high altitudes when the balloon travels toward the TDRWP.

Results: Spectral Analysis

TDRWP NEDOLWG Composite Spectral Analysis Plots



- TDRWP effective vertical resolution appears to be ~500 m.

Summary

- This analysis provides a status of activities performed for the TDRWP OAT.
 - TDRWP wind profiles compare well with concurrent balloon measurements.
 - RMS of all wind component deltas are 1.55 m/s (U) and 1.55 m/s (V).
 - Wind component deltas are generally smaller if balloon is closer to TDRWP.
 - Analysis shows expected results when considering data from previous testing.
 - TDRWP effective vertical resolution appears to be ~500 m.
 - Caveat exists in that the TDRWP contains instances of weak signal at high altitudes.
- OAT target completion in mid-late October, 2016.
- OAT data to be included in TDRWP full certification for SLS.

Backup

- Data and Methodology Details
- TDRWP / Balloon Comparison “blowback” case
- Previous OAT TDRWP/Balloon Comparison Results

Backup: Data Details

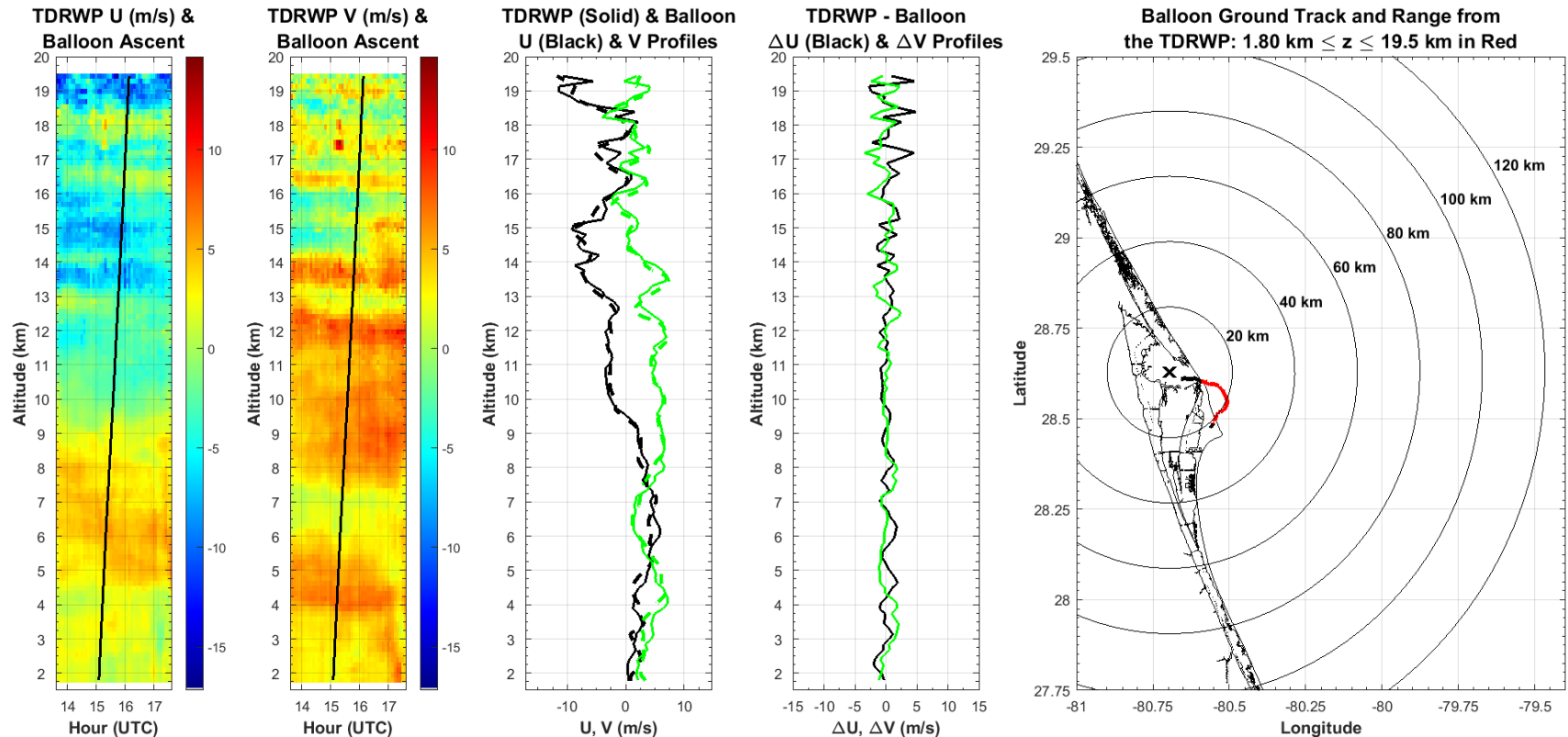
- Analysis period started June 22, 2016. Quick-look assessed data through July 1, 2016.
- TDRWP
 - Five-minute profiles for each day from 1,795-19,430 m, every 150 m.
 - Filled temporal data gaps for plotting.
 - Removed entire profiles during periods of deep convection that affected wind field (“QC”).
 - Each day contains at least 100 profile pairs.
- Balloon
 - Automated Meteorological Profiling System (AMPS) Low Resolution (LR) and High Resolution (HR) Flight Element (FE).
 - One-second data provided by the Cape Weather Station.
 - Variables processed for analysis consist of date, latitude, longitude, altitude, and smoothed wind components at each altitude up to 22,860 m (75,000 ft).
 - Profile must terminate at or above 15,240 m (50,000 ft) and not contain a 31 m (100 ft) vector shear exceeding 0.15 s^{-1} .
 - Separated temporally adjacent profiles by at least five minutes to avoid processing duplicate balloon profiles.

Backup: Methodology Details

- Plotted TDRWP time-height (t-z) sections of wind components, convection, and maximum first-guess-propagation (FGP) from all four beams.
- TDRWP / Balloon comparisons
 - Averaged all one-second balloon data within 75 m of each TDRWP altitude. At least 15 one-second reports must exist to report an average.
 - Temporally matched balloon and TDRWP data throughout balloon ascent.
 - Subtracted 7.5 minutes from TDRWP timestamp to account for temporal averaging.
 - Found closest TDRWP record to the balloon timestamp at each altitude.
 - TDRWP record must exist within five minutes of balloon timestamp.
 - Retained profile for comparison if at least 75% of the 119 TDRWP altitudes (i.e., range gates) contain reports from both sources.
 - Total of 30 balloon (all LRFE) profiles with concurrent TDRWP profiles existed that passed QC during the analysis period.
 - Plotted TDRWP wind component t-z sections with balloon ascent, TDRWP / balloon overlay and differences, and balloon ground track.

Backup: TDRWP / Balloon Comparison

TDRWP and Balloon Comparison, Case 36: Balloon Release at 07/10/2016 15:00 UTC



Backup: Previous OAT Results

